EIA/IS 731, Systems Engineering Capability Model (SECM)

Content

- **Background**
- **EIA/IS 731**
  - Definitions / Model Architecture
  - Focus Areas
  - Assessment / Use
  - Capability Levels
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- **Summary**

SE Standards & Capability Models (Systems Level)

Standards

- Provide requirements for good processes.
- Military standards
  - designed as contractual requirements.
  - ensure consistent processes.
- Commercial standards
  - designed for voluntary use.
- Legal document

Capability models

- Also provide requirements for good processes.
- Evaluate maturity or capability of process.
- Designed for voluntary use to show how to improve processes.
- Not legal document

Substantial overlap

Capability Models

1994-95 **SE Capability Maturity Model (SE-CMM) v1.0**

1995-96 **SE Capability Maturity Model (SE-CMM) v1.1**

1994 **SE Capability Assessment Model (SE-CAM)**

1998 **EIA / IS 731 SE Capability Model (SECM)**

2002 **Capability Maturity Model Integrated (CMMI)**

Standards

ISO 9001, Paragraph 4.4, Design Control

1969 **MIL-STD-499 (USAF) Systems Engineering Management**

1974 **MIL-STD-499A (USAF) Engineering Management**

1994 **EIA / IS 632 Systems Engineering**

1994 **MIL-STD-499B Systems Engineering** *Not Released*

1998 **EIA 632 Processes for Engineering a System**

2002 **ISO 15288 Standard for System Life Cycle Processes?**

1994 **IEEE 1220 Standard for Application and Management of the**

1998 **IEEE 1220 Standard for Application and Management of the**

Why Use A “Systems Engineering” Model?

- **Models give a framework for process improvement**
- **Models give a method of measuring progress**
- **Models provide means of learning from others**
- **Benchmarking can be done against peers**

EIA Interim Standard (EIA/IS 731)
Systems Engineering Capability

EIA Interim Standard

Systems Engineering Capability

EIA/IS 731

Part 1: Model

EIA/IS 731-1

EIA Interim Standard

Systems Engineering Capability

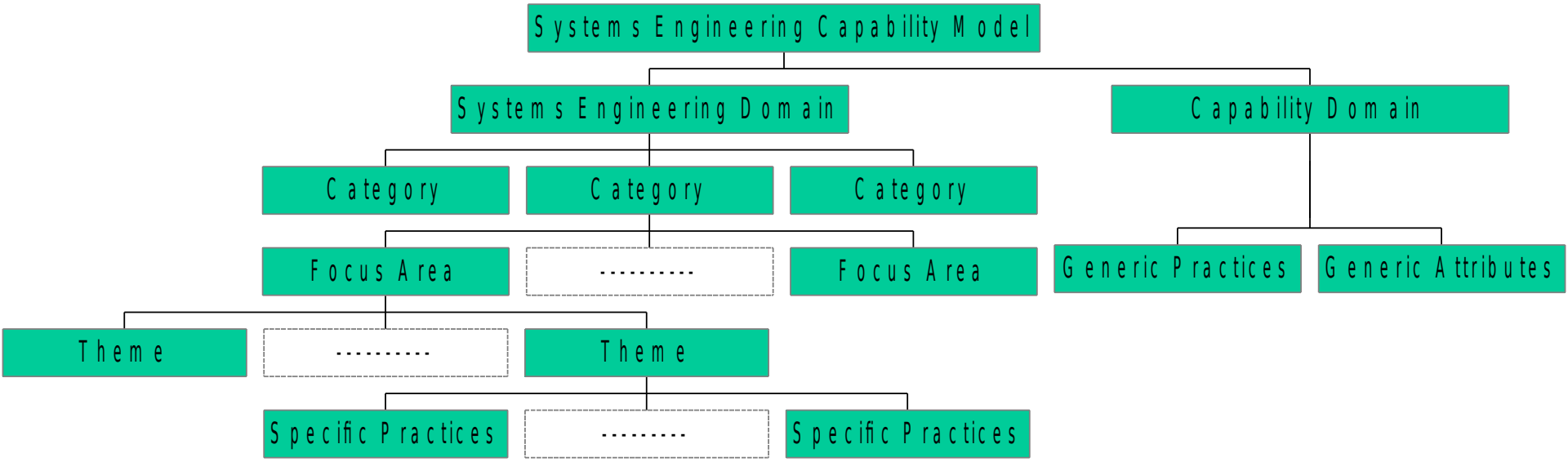
EIA/IS 731

Part 2: Appraisal Method

EIA/IS 731-2

http://www.geia.org/eoc/G47/731dwnld.htm

Model Architecture



Definitions

- **Focus Areas**
  - A set of related, unique practices that are indicative of SE capability for a specific activity.
- **Themes**
  - Subdivisions of a Focus Area that group a related set of Specific Practices
  - Themes put lists of practices in context and help readers interpret intent.

Definitions Continued

- **Elements**
  - Specific Practices (SP)
    - Activities that are essential to accomplishing the purpose of a FA or that helps to accomplish the purpose of the FA more effectively or efficiently
  - Generic Practices (GP)
    - Activities that are common to all FA(s)
    - When applied to a FA, enhances the capability to perform
  - Generic Attributes (GA)
    - Address behaviors or the quality of products and services which result from the accomplishment of tasks/activities

Categories

There are three natural high-level groupings of the 19 Focus Areas:

- **Technical:**
  - Indicates the technical aspects of Systems Engineering
  - Corresponds closely to EIA 632 and IEEE-1220-1994
- **Management:**
  - Focuses on Planning, Control, Information Management
- **Environment:**
  - Focuses on areas that “enable” systems engineering and align with business objectives

Focus Areas

- **Description**
- **Notes**
- **References**
- **Themes**
  - Description
  - Typical Work Products
  - Specific Practices

EIA / IS 731 SE Capability Model (SECM)	
Categories	**Focus Areas**
1.0 Technical	FA 1.1 Define Stakeholder and System Level Requirements FA 1.2 Define Technical Problem FA 1.3 Define Solution FA 1.4 Assess and Select FA 1.5 Integrate System FA 1.6 Verify System FA 1.7 Validate System
2.0 Management	FA 2.1 Plan and Organize FA 2.2 Monitor and Control FA 2.3 Integrate Disciplines FA 2.4 Coordinate with Suppliers FA 2.5 Manage Risk FA 2.6 Manage Data FA 2.7 Manage Configurations FA 2.8 Ensure Quality
3.0 Environment	FA 3.1 Define and Improve the Systems Engineering Process FA 3.2 Manage Competency FA 3.3 Manage Technology FA 3.4 Manage Systems Engineering Support Environment

FA 2.1 Plan and Organize

Themes

2.1-1 Critical Resources

2.1-2 Technical Approach

2.1-3 Work Breakdown Structure, Estimation, and Task Description

2.1-4 Schedules

2.1-5 Technical Management Plan

Specific Practices (2.1-2 Technical Approach)

SP 2.1-2-1a Determine a technical approach for the program.

SP 2.1-2-1b Estimate the magnitude and technical feasibility of the program.

SP 2.1-2-2a **Identify technical activities for the entire life cycle of the program**.

SP 2.1-2-2b **Identify key technical performance parameters**.

SP 2.1-2-2c **Establish thresholds or profiles for key technical performance parameters**.

SP 2.1-2-3 Identify and define a system life cycle with predefined stages of manageable size.

Assessment Method - Questionnaires

Table 6-2 - Questionnaire Distribution Table

Focus Area 2.1 Plan And Organize

Primary Recipients

- Senior product-level quality manager or lead (in environments with shared quality leadership responsibility, product leader for the product)

Secondary Recipients

- Product leaders for the products selected for appraisal
- Organizational quality manager, total quality management coordinator

Assessment Method - Questionnaires

Theme 2.1-2 Technical Approach

- SP 2.1-2-1a Is a technical approach determined for the program?
- SP 2.1-2-1b Are the magnitude and technical feasibility of the program estimated?
- SP 2.1-2-2a Are technical activities identified for the entire life cycle of the program?
- SP 2.1-2-2b Are key technical performance parameters identified?
- SP 2.1-2-2c Are thresholds or profiles established for key technical performance parameters?
- SP 2.1-2-3 Is a system life cycle with predefined stages of manageable size identified and defined?

(EIA/IS 731-2, Annex H, Appraisal Questionna

Assessment Method - Exploratory Questions
FA 2.1 Plan and Organize

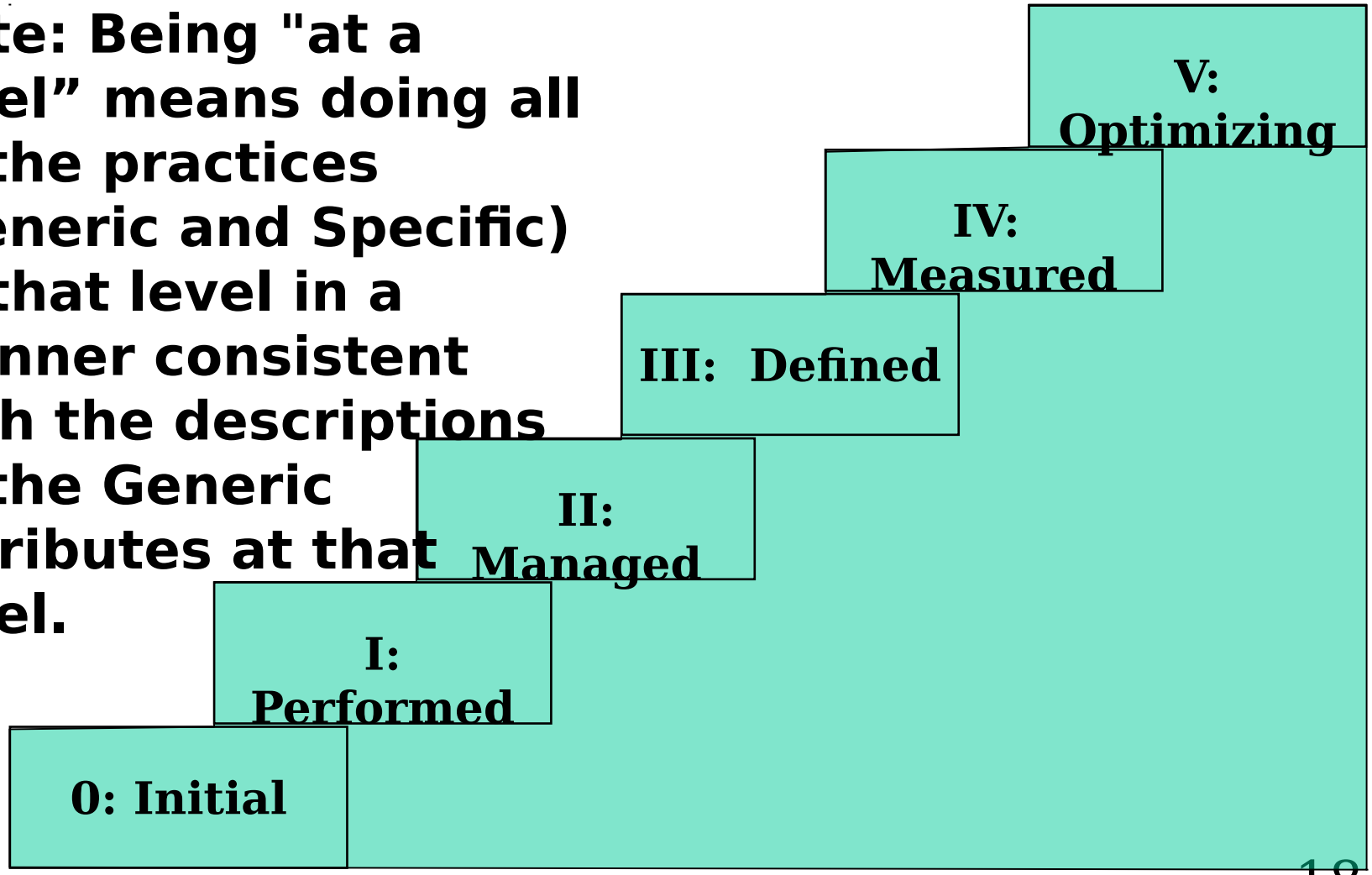
- **2.1-1 Describe how planning is done on your program.**
  - **Listen For:** Coverage of technical, cost, and schedule and system engineering management plan or technical management plan (i.e., SEMP or TMP)
- **2.1-2 How are estimates derived for engineering tasks?**
  - **Listen For:** Documented estimation procedures
- **2.1-3 How are changes in requirements reflected in the plan?**
  - **Listen For:** Review procedures and documented change procedure
- **2.1-4 How is systems engineering used in the planning process?**
  - **Listen For:** Work breakdown and participation and concurrence

(EIA/IS 731-2, Annex G, Individual Interview Explorat

EIA/IS 731-1 SECM	SECAM	SE-CMM
Sys. Engr. Technical Category	**System Engineering Process Category**	**Engineering Process Category**
FA 1.1 Define Stakeholder and System Level Requirements	KFA 3.1 System Concept Definition	PA 06 Understand Customer Needs & Expectations
FA 1.2 Define Technical Problem	KFA 3.2 Requirements and Functional Analysis	PA 02 Derive and Allocate Requirements
FA 1.3 Define Solution	KFA 3.2 System Design	PA 03 Evolve System Architecture
FA 1.4 Assess and Select	KFA 3.4 Integrated Engineering Analysis	PA 01 Analyze Candidate Solutions
FA 1.5 Integrate System	KFA 3.5 System Integration	PA 05 Integrate System
FA 1.6 Verify System	KFA 3.6 System Verification	PA 07 Verify & Validate System
FA 1.7 Validate System KFA	KFA 3.7 System Validation	PA 07 Verify & Validate System
Sys. Engr. Management Category	**Management Process Category**	**Project Process Category**
FA 2.1 Plan and Organize	KFA 1.1 Planning	PA 12 Plan Technical Effort
FA 2.2 Monitor and Control	KFA 1.2 Tracking and Oversight	PA 11 Monitor & Control Tech. Effort
FA 2.3 Integrate Disciplines	KFA 1.4 Intergroup Coordination	PA 04 Integrate Disciplines
FA 2.4 Coordinate with Suppliers	KFA 1.3 Subcontract Management	PA 18 Coordinate with Suppliers
FA 2.5 Manage Risk	KFA 1.7 Risk Management	PA 10 Manage Risk
FA 2.6 Manage Data	KFA 1.8 Data Management	(None)
FA 2.7 Manage Configurations	KFA 1.5 Configuration Management	PA 09 Manage Configurations
FA 2.8 Ensure Quality	KFA 1.6 Quality Management	PA 08 Ensure Quality
Sys. Engr. Environment Category	**Organization Process Category**	**Organizational Process Category**
FA 3.1 Define and Improve the Systems Engineering Process	KFA 2.1 Process Management and Improvement	PA 13/14 Define & Improve Org's Systems Engineering Process
FA 3.2 Manage Competency	KFA 2.2 Competency Development	PA 17 Provide Ongoing Skills and Knowledge
FA 3.3 Manage Technology	KFA 2.3 Technology Management	PA 15 Manage Product Line Evolution
FA 3.4 Manage Systems Engineering Support Environment	KFA 2.4 Environment and Tool Support	PA 16 Manage Systems Engineering Support Environment

Capability Levels

Note: Being "at a level" means doing all of the practices (Generic and Specific) at that level in a manner consistent with the descriptions of the Generic Attributes at that level.



EIA 731-1, Table 1 - Capability Levels		
Capability	**Process**	**Non-Process**
0 Initial	• Practices are not performed • general failure to perform activities • no easily identifiable work products • no proof tasks are accomplished	• activities and work products have little effectiveness or value • no assurance of success • information is difficult to identify • driving force for activities is indeterminate • no assurance of complexity management • no focus on the principles of systems engineering
1 Performed	• Specific Practices are performed • activities are done informally • non-rigorous plans and tracking • dependency on "heroes" • work products are in evidence • general recognition of need for activity	• activities are marginally effective and work products are of marginal utility • information is ad hoc • activities are driven only by immediate contractual or customer requirements • SE focus limited
2 Managed	• Specific Practices are performed, and performance is characterized by the Level 2 Generic Practices • policies define need for activities • processes are program specific • activities are planned, tracked, measured and verified • corrective actions are taken to assure the program specific process is followed work products are reviewed for adequacy • defects are removed from work products • work products are controlled	• activities are adequately effective and work products are of adequate utility • key information managed • activities driven by customer and stakeholder needs in a suitable manner • SE focus is requirements through design

3 Defined	• Specific Practices are performed, and performance is characterized by the Level 3 Generic Practices • processes are well defined • the organization has a standard systems engineering process • tailoring guidelines exist for the standard systems engineering process • the standard systems engineering process is tailored and used by each program • tailoring is reviewed and approved • customer feedback is obtained • data are collected on the performance of the tailored process • qualitative process improvement is performed on both standard and tailored processes	• activities are significantly effective and work products are of significant utility • consistent program success • information is managed and integrated • activities driven by benefit to program • SE focus is requirements through operation
4 Measured	• Specific Practices are performed, and performance is characterized by the Level 4 Generic Practices • metrics are derived from data on the tailored process • the tailored process is quantitatively understood • performance of the tailored process can be predicted • tailored process induced defects are identified • measurable quality goals are established for systems engineering work products • causal analyses are performed for the tailored process • tailored processes are quantitatively improved • standard process continues to be qualitatively improved	• activities are measurably effective and work products are of measurably significant utility • all information fully integrated • activities driven by systems engineering benefit • SE focus on all phases of product life cycle
5 Optimizing	• Specific Practices are performed, and performance is characterized by the Level 5 Generic Practices • process effectiveness goals are established for the program based upon business objectives • causal analyses are performed for the standard process • standard processes are quantitatively improved • improvements to the standard process are flowed down into each tailored process	• activities are effectively balanced and work products effectively provide their intended utility • activities driven by systems engineering and organizational benefit • complexity management is fully scaleable • SE focus is product life cycle & strategic • applications

Generic Practices

GP 2.1 Follow recorded and approved plans and processes, that were developed to meet program performance goals, in implementing the Focus Area.

GP 2.2 Verify compliance with approved plans and processes, and take appropriate action when performance deviates from plan or when processes are not followed.

GP 3.1 Standardize and record a well-defined FA process for the organization that is designed to meet specific business goals, and is based on experiences captured from previous programs.

GP 3.2 Tailor the organization's standard process using standard guidelines to meet specific program or organizational needs.

GP 3.3 Implement and improve the FA activities (i.e., tailored process) per established and approved formal procedures.

GP 3.4 Improve the organization's standard process using information from work product reviews and process compliance reviews.

GP 4.1 Collect and analyze metrics to determine the performance of the tailored FA activities.

GP 4.2 Take appropriate action to align tailored FA performance and expectations.

GP 5.1 Identify FA activities for which it is appropriate, and inappropriate, to quantify process repeatability.

GP 5.2 Establish quantitative goals for improving the effectiveness of the standard process.

GP 5.3 Improve the organization's standard process based on data and metrics collected from a continuing program of process compliance reviews and work product reviews.

GP 5.4 Perform causal analysis of process and work product defects and eliminate causes of variation in quality, cost, and cycle time by changing the standard process.

Table 2 - Definition of Generic Attributes			
Capability Level	**Criteria**	**Generic Attribute 1: Effectiveness** *A measure of the performance of an activity. SECM characterizes effectiveness as marginal, adequate, significant, measurably significant, and optimal.* These are defined as:	**Generic Attribute 2: Value** *A measure of the desirability of the products of an activity. SECM characterizes value as marginal, adequate, significant, measurably significant, and optimal.* These are defined as:
1 Performed	Marginal	Effort is being expended but it is not clear that the benefits received for the effort invested are worth the cost of the effort. The effort could be removed without causing significant impact to the program or organization.	Products are generated by the activity, but it is not clear that the products are of use to those for whom they are intended. The products could be removed without causing significant impact to the program or organization.
2 Managed	Adequate	Effort is being expended and the activities provide reasonable benefit to the program or organization.	Products generated by the activity provide reasonable benefit to those that use them. Products providing adequate value are generally used by those for whom they are intended.
3 Defined	Significant	Effort being expended is obviously beneficial to the program or organization.	Products generated by the activity are obviously beneficial to those that use them. Products of significant value are avidly sought out and used by those for whom they are intended.
4 Measured	Measurably Significant	Effort being expended and the benefit are measured and found to be significant to the program or organization.	The benefits of each product generated by the activity are measured and found to be of significant value to the program or organization.
5 Optimizing	Optimal	Effort expended is providing maximum benefit for the amount of effort, i.e., more effort results in a diminishing return to the program or organization.	Value of the products generated by the activity are of maximum utility to the program or organization.

Systems Engineering Capability Model (SECM) (Systems Level)

- **DCMC Engineering Role**
  - Be familiar with the various systems engineering models and their use as guidance and reference tools
  - Use them to evaluate the systems and test engineering processes
  - Use them for risk assessment and risk handling